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ABSTRACT

THERE IS A GROWING NEED FOR SUPPORTIVE PERSONNEL WITH TECHNICAL PREPARATION IN WATER AND WASTEWATER PURIFICATION AND WATER RESOURCE CONSERVATION. A CURRICULUM AND PROGRAM GUIDE WAS DEVELOPED IN 1965-66 BY FAYETTEVILLE TECHNICAL INSTITUTE FOR USE BY INSTITUTIONS INTERESTED IN ESTABLISHING A PROGRAM TO EDUCATE TECHNICIANS. MEETING THE NEED FOR INCREASING WATER TECHNICIAN PROGRAMS LIES WITHIN THE REACH OF OUR NATIONAL LEADERS, PARTICULARLY EMPLOYERS. METHODS SUCH AS IMPROVING STUDENT RECRUITMENT AND STUDENT DEVELOPMENT PROGRAMS, UPGRADING PRESENT EMPLOYEES IN POST-HIGH SCHOOL PROGRAMS, AND UTILIZING FUNDS PROVIDED BY CURRENT VOCATIONAL EDUCATION LEGISLATION SHOULD BE UTILIZED. A SUGGESTED REFERENCE AVAILABILITY LIST IS APPENDED. (GH)

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EDUCATION OF TECHNICIANS FOR WATER CONSERVATION AND WASTEWATER CONTROL

Public concern about water conservation and continued pollution, impending water shortages because of increased water consumption by urban populations and industry, and technological advancements in treatment processes have highlighted the lack of skilled technicians to assist engineers, scientists, and managers in water resource development and wastewater control.

The Magnitude of need for supportive personnel with technical preparation in water and wastewater purification and water resource conservation has been recognized only recently. In August 1967 the Federal Water Pollution Control Administration of the U. S. Department of Interior submitted to Congress a special report entitled "Manpower and Training Needs in Water Pollution Control."

It showed that State and local agencies, industrial waste treatment programs, and consulting engineers needed 10,300 technicians in fiscal year 1967 and would need 33,500 in fiscal year 1972, an increase of 23,200 within 5 years. This country did not have 10,300 technicians in 1967. It was evident that a concerted effort had to be made by government, industry, and educational agencies to meet a need for 33,500 water and wastewater technicians in 1972.

The Federal Water Pollution Administration compiled the report in compliance with the Clean Water Restoration Act of 1966, which provided the Administration with funds for promoting the education of professional engineers and scientists, technicians, and operators for water purification systems and wastewater processing plants. The report is available for 20 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

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Presentation by Water J. Brooking, Program Officer, Technical Education, U. S. Office of Education at the Operator Training Workshop at the Water Pollution Control Federation held prior to their annual National Convention, on October 4, 1969 at the Statler Hilton Hotel, Dallas, Texas.

DEVELOPMENT OF A CURRICULUM AND PROGRAM GUIDE

The U. S. Office of Education, foreseeing the growing need for specialized technicians in the field of water pollution control, undertook the preparation of a suggested 2-year post high school program and curriculum guide for educating water and wastewater technicians in community colleges, technical institutes, and in divisions of 4-year colleges and universities.

A 1964 survey of technician education offerings in the Nation's schools showed that only one, Fayetteville Technical Institute at Fayetteville, North Carolina, had a program for water and wastewater technicians. It was a newly begun program initiated under the leadership of the President, Howard Boudreau, with Archie Purcell as head of the program.

Before Mr. Boudreau, and his staff initiated the water and wastewater technician program they conducted an extensive regional and almost a national survey for more than 2 years to determine:

A. Present and future needs for technicians in the field;

B. Employment opportunities;

C. Salary expectations and opportunities for career advancement;

D. Skills and knowledge required for technicians;

E. Specific and general duties;

F. Curriculum content;

G. Facilities needed to provide the skills and knowledge required of technicians.

During the survey an advisory committee of State and local water and wastewater resources and processing engineers, scientists, employers and educators examined the problems related to and the feasibility of providing a 2-year post high school program for the preparation of water and wastewater technicians. Specialists from the Robert A. Taft Sanitary Engineering Center of the U. S. Public Health Service in Cincinnati, Ohio, were consulted; and the

Fayetteville staff frequently consulted with the Center's engineers and scientists. The water pumping and treating laboratory facility installed at Fayetteville Technical Institute was modeled in some degree after the facilities of the Robert A. Taft Sanitary Engineering Center.

After the decision was made to initiate a water and wastewater technician program, Mr. Boudreau and his staff worked intensively for an entire summer with the North Carolina State Department of Education curriculum laboratory to prepare the course outlines for the program. In the fall of 1964, the Fayetteville program began.

In June 1965, Fayetteville Technical Institute agreed to prepare a curriculum guide under a contract with the Office of Education's Division of Vocational and Technical Education. A final review draft of the curriculum guide was made available to the Office of Education in July 1966, at which time a national review committee of representatives of the Water Pollution Control Federation, Robert A. Taft Center, State and local water pollution control officials and employers, consulting engineers and educators met in Washington, D.C., for a two-day page-by-page review of the curriculum guide. At that same time, copies were sent to community colleges, technical institutes, and colleges and universities with requests for written reviews and criticism of content.

Following the reviews, the technical education staff of the U. S. Office of Education, in cooperation with the Water Pollution Control Federation and the staff of Fayetteville Technical Institute, revised parts of the guide and then edited the completed guide for printing and distribution.

In light of its important responsibilities for technician education, the Federal Water Pollution Control Administration of the U. S. Department of the Interior cooperated with the Office of Education and provided funds to print the curriculum guide entitled Water and Wastewater Technology, A Suggested 2-Year Post High School Curriculum. Thus the guide became a joint interdepartmental publication.

The publication became available from the Government Printing Office in May 1969 after a delay caused by the Government's budgetary limitation of printing funds.

Draft copies of the original curriculum produced by the Fayetteville staff were distributed to the States, and to educational institutions that had expressed interest in starting water and wastewater technology programs. Several institutions which used the review draft of the guide to initiate programs had water treatment or wastewater plants as a part of their campus facilities; a few institutions made cooperative arrangements with nearby plants.

PURPOSE OF THE CURRICULUM GUIDE

The purpose of this curriculum guide is to suggest a model plan to help private or public community colleges, technical institutes, or 4-year colleges to start, or evaluate and improve, water and wastewater technology programs.

Experiences show that the guide provides a starting point for school administrators who have the services of strong, local advisory committees. The guide offers proven information and a program plan which can be modified to meet particular needs and objectives, permitting administrators to initiate a program with minimum uncertainty about the program meeting objectives. It can be used for full-time, 2-year post high school preparatory programs, cooperative work (with pay) and study programs, and for upgrading employed personnel.

The guide serves a second use. It trains teachers of technicians and operators because it has a coherant and authoritive source of information with instructors of water and wastewater programs, and the department heads need.

Graduates of this curriculum can expect to find employment among the many areas of sanitation, public health, and physical facilities operation. Each area may require different abilities and variations in specialized knowledge and skills, most of which will be developed by continued study on the job or part-time study. Major areas or clusters of job opportunities for water and wastewater technicians as described by employers include:

1. Research and Development Technician: A technician working directly with engineers and scientists in developing new devices or processes or in doing basic research.

2. Sales and Services Technician: A technician representing a company and its products, dealing directly with customers. He advises the customer, and is capable of installing and operating equipment, of trouble shooting, and of training the customer's personnel to service and maintain the equipment.
3. Plant Operator: A technician working as a water purification plant operator or wastewater treatment plant operator, for a municipal, industrial, or private facility.
4. Regulatory Technician: A technician working for a local State or Federal agency which has regulatory responsibilities in the field of water sanitation and public health. The technician's responsibilities would include such duties as stream monitoring and water and wastewater sampling, analysis, and control.
5. Design and Construction Technician: A technician working for consulting engineers or contractors, assisting with the design or construction of water distribution or treatment plants and wastewater collection systems or treatment plants.

Examples of work titles in various clusters of employment opportunities in the water and wastewater field are:

1. Public health engineering aide
2. Sanitation aide
3. Water and waste treatment
4. Stream sanitation technician
5. Technical sales and service representative

Job experience and encouragement by employers to continue study almost assures advancement to supervisory and mangerial positions for technicians who have the personal qualities for, and want, supervisory responsibilities. They may become foremen, supervisors,

managers, or superintendents of operations or programs associated with water conservation, purification or wastewater treatment.

CONTENT OF THE CURRICULUM GUIDE

To provide a quick overview of the content of the guide, the table of contents, curriculum outline, and a brief description of each course follows:

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    Physics II (Electricity and Light)
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CURRICULUM OUTLINE

	Class	Hours Per Week Laboratory	Outside Study	Total
First Semester				
Introduction to Water and Wastewater Technology and Related Fields	3	3	6	12
Mathematics I (Technical)	5	0	10	15
Physics I (Heat and Mechanics)	3	3	6	12
General Drafting	0	8	0	8
Communication Skills	3	0	6	9
	14	14	28	56
Second Semester				
Mathematics II (Technical)	4	0	8	12
Technical Reporting	2	0	4	6
Basic Hydraulics for Water and Wastewater	2	6	4	13
Microbiology for Water and Wastewater	3	6	4	12
Physics II (Electricity and Light)	3	4	6	13
	14	14	28	56
Third Semester				
Sanitary Chemistry and Microbiology I	2	6	4	12
Water Supply and Wastewater Control	2	4	4	10
Water Purification	3	3	6	12
Surveying	2	6	4	12
General and IndustrialEconomics	3	0	6	9
	12	19	24	55
Fourth Semester				
Sanitary Chemistry and Microbiology II	2	6	4	12
Wastewater Treatment	2	4	4	10
Instrumentation and Controls	3	2	6	11
Contracts, Specifications, Codes, and Estimates and Costs	3	4	6	13
Industrial Organizations, Institutions, and Government	3	0	6	9
	13	16	26	55

BRIEF DESCRIPTION OF COURSES

First Semester

Introduction to Water and Wastewater Technology and Related Fields

A study of methods of disease transmission, hygienic excreta disposal, municipal and industrial wastewater collection and treatment, characteristics of water, water treatment, protection of ground water, insect and rodent control, solid waste collection and disposal, milk and food sanitation, swimming pool sanitation, and industrial hygiene.

Mathematics I (Technical)

A course in algebra, analytic geometry, and introductory trigonometry, with particular stress on slopes and rates of change and the determination of maxima and minima conditions.

Physics I (Heat and Mechanics)

A study of the basic principles of mechanics and heat, with the emphasis in both laboratory and lecture on the scientific method. Laboratory-oriented to provide application of principles learned in the mathematics course, including use of the slide rule for computation of data.

General Drafting

A beginning course for students who have had little or no previouw experience in drafting. The principal objectives are to provide an elementrary understanding of: Orthographic projection; isometric and oblique sketching; detail and assembly working drawings; principles and applications of descriptive geometry to drawings; plan, profite, and topographic drawing; how to use handbooks and other resource materials. Interpretation of industrial sketches and prints is introduced.

Communication Skills

A program designed to increase competence in reading, writing, and talking, and understanding oral instructions.

Second Semester

Mathematics II (Technical)

A continuation of mathematics I which completes the study of necessary principles of analytic geometry and concludes with introductory phases of calculus required for optimum performance in hydraulics and process control.

Technical Reporting

A study of effective ways of presenting information, with emphasis on the use of graphs, drawings, sketches, and outlines for various types of oral presentations and written reports.

Basic Hydraulics for Water and Wastewater Technology

A basic study of closed conduit and open channel flow, including stream flow, subterranean flow, runoff, pump characteristics, and wave action.

Microbiology for Water and Wastewater Technology

A basic course in microbiology with emphasis on microorganisms, and on the laboratory procedures for identifying and differentiating organisms pe-

culiar to water and wastewater treatment, and related public health and stream sanitation problems.

Physics II (Electricity and Light)

A study of the basic principles of electricity, electrical circuitry, motors, and light, emphasizing the concepts of physics and laboratory-oriented to provide application of principles.

Third Semester

Sanitary Chemistry and Microbiology I

Theory and laboratory techniques for all control tests of water purification including: Bacteriology, color, turbidity, PH, alklinity, hardness, coagulations, chlorides, flourides, iron, mananese, detergents, bactericides, and nitrates. It includes basic "in-plant studies at nearby plants."

Water Supply and Wastewater Control

A course designed to familiarize the student with the elementary engineering aspects of water supply and distribution; and of wastewater collection, removal, and disposal.

Water Purification

A study of basic principles of water purification including: Aeration sedimentation, rapid sand filtration, chlorination, treatment chemicals, taste and odor control, bacteriological control, mineral control, design criteria, maintenance programs, and operational problems. New processes and recent developments are studied. Criteria, rules, regulations, forms, and records associated with the field are considered.

Surveying

A study of the elementary theory and practice of plane surveying including taping, differential and profile leveling, cross sections, earth work computations; and transit, stadia, and transit-tape surveys.

General and Industrial Economics

A study of the principles of general and industrial economics; an analysis of the factors involved and the importance of cost control in an industrial or municipal enterprise.

Fourth Semester

Sanitary Chemistry and Microbiology II

A study of the theory and laboratory techniques for the determination of solids, dissolved oxygen, oxygen consumed, relative stability, bacteria, biochemical oxygen demand, organic nitrogen, volatile acids, and toxic metals in liquid media. The course includes stream studies and in-plant studies.

Wastewater Treatment

This course is designed to familiarize the student with the elementary engineering aspects of design, operation, process control, and maintenance of wastewater treatment plants and facilities.

Instrumentation and Controls

An elementary study of hydraulic, pneumatic, mechanical, electrical and electronic control systems and components. It includes a basic description, analysis, and explanation of operation of instrumental controls for water and wastewater plants. Typical performance characteristics, accuracy, and applications of instruments are studied.

Contracts, Specifications, Codes, and Estimates and Costs

A course designed to teach the methods and procedures of consummating and engineering contract with code and cost limitations.

Industrial Organizations, Institutions and Government

A study of the roles played by labor and management in the development of American industry. Analysis is made of forces affecting labor supply, employment, and industrial relations in a democratic system of government.

INCREASING THE NATION'S WATER TECHNICIAN PROGRAMS

We suggest that meeting the increased manpower needs in water and wastewater technology lies within reach of the water resources leadership of the Nation, particularly employers. Private industries with liquid waste disposal problems are a significant group of employers because they are large supporters of the public education system through Federal, State and local taxes.

Substantial amounts of Federal, State, and local tax funds are available for the education of skilled workmen and technicians in every State. These programs can and should be provided in junior colleges, technical institutes, area vocational and technical schools, and branches of 4-year institutions throughout the Nation. There are a few such programs already, and they provide a nucleus of knowledgeable directors and exemplary administration which can assist others in developing good programs in water conservation and purification technology.

These institutions also can and often do educate other technicians and specialists who are needed by employers in the field. They may be electronic, mechanical, industrial production, data processing, or a number of other specialists.

When a capable department head in a favorable administrative atmosphere establishes a post high school technical education program with the full support and advisory assistance of local employers, experience shows that his institution will serve the needs of employers, offer realistic technical courses and plan effectively for student recruitment and placement.

The valuable assistance given by the Water Pollution Control Federation in the preparation of this curriculum guide and its sustained interest provides an opportunity for the members to knowledgeably assist educational leaders of their communities in establishing or improving programs for training water resource conservation and purification technicians and related personnel.

The final effectiveness of the Federation's contribution will be realized to the degree that its members, or the education committees and employers they represent, assist schools in implementing training programs.

Local employers and members of the Water Pollution Control Federation can assist educational institutions by:

1. Getting acquainted with the facilities, personnel, and leadership of local educational institutions and making known the need of local industry for highly skilled water and wastewater technicians and related personnel.

2. Assisting in surveys and defining the present and projected need

for highly skilled technicians to be trained in full-time preparatory programs, and in programs for updating and upgrading the personnel already employed in the locality.

3. Serving on advisory committees on curriculum content, equipment, and the objectives of a program for educating highly skilled technicians. It is here that the curriculum guide can form a common ground of suggested information of what is practicable and required regarding course content, facilities, and teaching staff for high quality instruction of technicians for this field.

4. Assisting in obtaining, developing, and retaining qualified teachers for local technical education programs; and in encouraging teachers to maintain up-to-date technical competency, enthusiasm, and active involvement with the local employers in the field. Active participation by teachers in local technical society activities should be encouraged as one means of accomplishing these objectives.

5. Assisting in leading school personnel, parents, students, and guidance personnel to an understanding of the career opportunities offered in the field of water resources and purification; and encouraging public support of the local educational institutions for such a program.

6. Providing if possible, a cooperative work experience for promising young students who are studying to be technicians, either by summer work or by cooperative educational programs.

7. Encouraging school administrators to cooperate with their State vocational education administrators, with Federal and State Water Pollution Control Administration personnel so that maximum use can be made of Federal and State funds alloted for meeting technical manpower needs.

STUDENT RECRUITING AND STUDENT DEVELOPMENT PROGRAMS

Recruiting students for full-time 2-year post high school technician education programs generally, and for water and wastewater programs in particular, continues to be a very real problem. Very few students have been told of the excellent opportunities for water technicians.

The increasingly critical shortage of specialized technical and supportive workers on the one hand and the evident supply of educable persons on the other--those who have left high school or who have been graduated from high school but who are not pursuing or ganized programs to prepare them for careers in a technological society--represents and unprecendented

challenge to educators of technicians, and to employers who need well-prepared technicians.

For each student who enters a program there are perhaps three or four who apply for admittance and are rejected, or do not apply because they do not want a 4-year baccalaureate program or believe they cannot be successful in further organized study. Many seek employment, or enter the military service where they see modern technology in operation and realize that they need further education to obtain the kind of challenging and responsible technical work they want.

To provide a large population of able, but fully qualified, students including employed or underemployed persons, with educational programs that meet technical worker requirements essentially requires organized Student Development (pretechnical remedial or preparatory "prep" school) Educational services for willing and well-motivated students. These services must start at the educational level attained by each individual and provide the missing reading, science or mathematics required for successful mastery of the occupational program to which the student aspires.

These Student Development programs must be "individual," in the sense that they provide a special program for each individual to repair his academic deficiencies. They must be administered in such a way as to relate to the special field of interest in which the particular student expects to prepare himself and a make a career.

While the program for each individual must be tailored to his needs and must include from the beginning some direct involvement (usually in laboratory work) in his special field of interest, groups of students with similar gaps in academic preparation can be formed into classes large

enough to justify special staff, facilities and teaching programs to serve their needs. Employed or underemployed adults in the field of water or wastewater treatment would have a common interest and the motivation for student development programs.

Program administrators state that when students have been able to remove academic deficiencies as part of their occupational study programs, the morale of the students and the instructor are improved; the number of students who drop out because of academic failure is greatly reduced; the total cost of educating these specialized occupational personnel is reduced because of better use of facilities, teachers, and fewer failures; and better qualified graduates are produced, making them more sought after by employers. Many full-time students who start pretechnical programs switch from such "glamorous" objectives as electronics or mechanical technology, for example, to water and wastewater or instrumentation when they learn of the opportunities available in these fields. Thus, pretechnical programs help recruit students for many new fields of technology.

The value to the individual of such an opportunity usually allows him to arrive at a degree of productivity and responsibility in 3 to 5 years instead of the otherwise required 12 to 15 years of on the job diligent work and study. This means a net gain of some 10 years of high productivity which benefits both the individual and the employer--a direct result of the student having an opportunity to overcome his academic deficiencies and successfully prepare himself for higher level employment.

UPGRADING SKILLED WATER AND WASTEWATER EMPLOYEES IN POST HIGH SCHOOL PROGRAMS.

When the water and wastewater technician educating program is established in an institution (and only when the program is estabiiehd), there

will then be an optimum environment for approaching the important task of providing supplementary organized study of upgrade employed water and wastewater or related mechanics, operators, and skilled workers to the technician level; or to the supervisory level by providing management courses.

When a community college or a technical college has an efficient department head and skilled teachers of technical specialties, mathematics, physics, chemistry, and microbiology, as these apply to water conservation or purification, the ground work is done; and the environment is ideal for bringing the specialised scientific education and the related mathematics to ambitious and highly motivated mechanics and skilled workers who are on employers' payrolls.

If a sufficient number of persons are available in one employer's plant, the teachers can be brought to the plant. However, it is better if the employees can attend classes on campus with laboratories and a collegiate environment, taught by persons who know how to supply adults who have job experience in the field with the technical background they lack.

Motivation of older employees seems to be an area of some difficulty for employers. The British system of providing weekly or even daily released time with pay for selected employees has been very successful Employees who are willing to study, show ambition, and aspire to the technician level are given short, intensive courses in technical programs planned particularly for them by the employers and school staffs. This has the educational advantage of permitting the employees who are working most of the time on the job to apply the newly learned information daily.

To start such programs in an established institution with a water and

wastewater technology program requires planning and,above all, the support of the employer. There is some doubt that merely to inform selected employees of available and approved programs will stimulate them sufficiently to undertake the study. It may not even be enough to suggest to them that the company will pay the cost of successfully completed schooling. The skilled workers with 10 to 15 years of experience often are so busy with family responsibilities, other off-the-job duties and activities, and recreational interests that they find it difficult to arrange their time for formal study.

The British "block time release" (or sandwich) programs of formal study supplementing daily work seem to succeed because the programs for selected employees are planned by their employers and the school staff, and the employees are paid their regular work rate while attending school. The nearest feasible approach to this system in the United States is the cooperative education program in which employers accept students for part-time paid employment, alternated with periods of organized class and laboratory study. Employers may also send full-time employees on released time to school for the technical study they need. There should be many more co-op programs.

To make such a program work involves difficult policy decisions, cost decisions, inter- and intraorganizational adjustments and arrangements on the part of employers. However, the critical need for better qualified technicians in water purification and conservation should cause the necessary decisions and adjustments to be made.

CURRENT VOCATIONAL EDUCATION LEGISLATION AND ITS ADMINISTRATION

The Office of Education, U. S. Department of Health, Education, and Welfare, administers the vocational education legislation which supports programs to educate technicians in public post high school institutions.

In recognition of the growing demand for highly skilled technicians, the Vocational Education Act of 1963 made permanent the authorization for training technicians as provided for in Title VIII of the National Defense Education Act. The 1963 Act also authorized increased support to extend vocational and technical education programs to persons of all ages.

Five years later, Congress passed the Vocational Education Amendments of 1968 and authorized substantial increases for vocational and technical education, with mandatory set-asides for post high school programs. Most of the Federal allotments require state or local matching funds; traditionally, States overmatch Federal allotments 3 to 4.

The 1968 legislation included other provisions of special interest to educators of water and wastewater technicians. It authorizes:

*funds for continuing work-study programs which offer financial assistance to disadvantaged youth;

*funds for developing exemplary programs or pilot projects to (1) familiarize elementary and secondary school students with new and emerging occupations and the skills required; (2) offer students vocational-educational experiences through work during the school year or in the summer; and (3) provide guidance, counseling, and job placement services;

*funds for expanding cooperative work-study programs to (1) enable

students to work part-time for pay and acquire a formal education in preparation for employment, and (2) foster a partnership between the schools and local employers;

*funds for teacher-education programs, and for training supervisors and administrators of vocational education;

*funds for collecting necessary manpower data.

Federal funds under the 1968 legislation are administered through State Directors of Vocational Education with the assistance of a State Advisory Committee. The legislation requires each State to have such a committee. Employers and others who wish to become active promoters or supporters of programs usually begin by working with administrators of local junior colleges, technical institutes, or other types of post-secondary schools.

SUGGESTED REFERENCES which may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

*OE-80041 Civil Technology - Highway and Structural Options - A Suggested 2-Year Post High School Curriculum - 60¢

*OE-80031 Chemical Technology - A Suggested 2-Year Post High School Curriculum - 75¢

*OE80056 Criteria for Technician Education - A Suggested Guide - 45¢

*OE80009A Electronic Technology (Revised) - A Suggested 2-Year Post High School Curriculum - $1.00

*OE-80033 Instrumentation Technology - A Suggested 2-Year Post High School Curriculum - 75¢

*OE-80019 Mechanical Technology - Design and Production - A Suggested 2-Year Post High School Curriculum - 70¢

*OE-80049 Pretechnical Post High School Programs - A Suggested Guide - 45¢

*OE-80037 Scientific and Technical Societies Pertinent to the Education of Technicians - 35¢

*OE-80057 Water and Wastewater Technology - A Suggested 2-Year Post High School Curriculum - $1.50 (April 1969)

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